JOINT RISK MANAGEMENT SECTION

Canadian Institute of Actuaries
Casualty Actuarial Society
Society of Actuaries

Risk management

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Actuaries
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Risk management

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JOINT RISK MANAGEMENT SECTION

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ARTICLES NEEDED FOR RISK MANAGEMENT

Your help and participation is needed and welcomed. All articles will include a byline to give you full credit for your effort. If you would like to submit an article, please contact David Schraub, JRMS Staff Partner, at *dschraub@soa.org*. The next issues of *Risk Management* will be published:

PUBLICATION DATES	SUBMISSION DEADLINES
December 2015	September 1, 2015
March 2016	December 1, 2015
August 2016	May 1, 2016

PREFERRED FORMAT

In order to efficiently handle articles, please use the following format when submitting articles:

- Word document
- Article length 500-2,000 words
- Author photo (quality must be 300 DPI)
- Name, title, company, city, state and email
- One pull quote (sentence/fragment) for every 500 words
- Times New Roman, 10-point
- Original PowerPoint or Excel files for complex exhibits

If you must submit articles in another manner, please call Kathryn Baker, 847.706.3501, at the Society of Actuaries for help.

Members Speak!

Love an article or strongly disagree with the opinion developed in another paper? Please share any comments or feedback on the JRMS newsletter with David Schraub at dschraub@soa.org.

Do you have a Risk Management question?

Ask us! Please send us your questions (dschraub@soa.org) and we will publish the questions and answers for everyone's benefit.

Chairperson's Corner

By Lloyd Milani

AH, SUMMER IS FINALLY HERE! At least that is what most of us in the northern part of the continent hope is the case. And with summertime comes an opportunity to kick back, take some time off and recharge those batteries. It's also an opportunity to catch up on recent SOA emails and newsletters. And why not picture yourself accomplishing this task while listening to the call of the loon as you sit by the dock of your cottage.

As you skim through some of these publications, the email from Errol Cramer with the subject line "Plain Talk: Collaboration, Competition and Collegiality" catches your eye. Being a member of three North American actuarial organizations, you think to yourself, how each of these organization plays a specific role, but you have also seen firsthand the collaboration that takes place within these organizations. As Errol points out in his email, the Joint Risk Management Section (JRMS) is a good example of this collaboration between actuarial organizations. The JRMS council is made of members from the Casualty Actuarial Society (CAS), Canadian Institute of Actuaries (CIA), and the Society of Actuaries (SOA). This group of professionals work together with the goal of improving knowledge within the field of risk management.

Sorting through more piles of paper, you come across copies of the slide decks from the ERM Symposium in Washington you attended in the middle of June. The agenda was rich with risk management content including sessions on Emerging Risks, Global Threats to Cyber Security, and Return on Economic Capital Frameworks: Design and Implementation Challenges. The meeting was a great opportunity to meet up with other actuaries in risk management and discuss issues like ORSA implementation and its challenges.

After watching the sun set, you move by the campfire and remind yourself that the SOA elections are soon approaching. There are eight candidates running for the JRMS council this year. No matter who is elected, next year's council will have an exciting new look and feel. You make a mental note to look out for the ballot between August 17 and September 4 as you realize it is important that you let your voice be heard in order to make the Society of Actuaries and its councils as effective as possible.

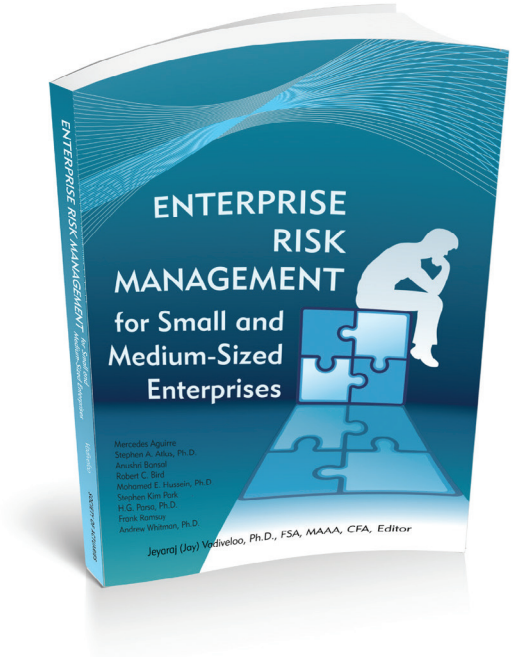
Lloyd Milani, FSA, FCIA, MAAA, is SVP & chief risk officer at Munich Reinsurance Co in Toronto, ON. He can be reached at *lmilani@munichre.ca.*

The JRMS council members are an integral part of process that sets the agenda each year. In addition to the newsletter and webcasts, the JRMS is working on a new pilot initiative this year where they will be hosting virtual "town hall" meetings. The attendance will be limited to 50 people so that it gives participants a good chance to partake in the discussions. The first meeting is targeted for the fourth quarter of 2015. Look for the registration email to be sent out soon.

Well, it's back to the dock to view the spectacular night sky. You are able to identify a few constellations, planets and stars. If you are really lucky you may even see a meteorite or two streak across the sky.

SOCIETY OF ACTUARIES

ENTERPRISE RISK MANAGEMENT FOR SMALL AND MEDIUM-SIZED ENTERPRISES



This new book just published by the Society of Actuaries is a valuable resource for anyone wanting a greater awareness and understanding of the need for establishing an ERM framework in any size enterprise.

Written by 10 experts on the topic, this is the first time ERM has been explored in a comprehensive manner for the largest and fastest growing business segment in the United States—small and medium-sized enterprises (SMEs).

Every chapter includes practical and implementable suggestions on how to create an ERM environment. Topics include:

- Steps to create a viable and dynamic ERM environment
- Risk analysis of property and casualty claims management practices
- Impact of the Affordable Care Act on small businesses
- And much more!

Order your copy today at ***SOA.org.***

Letter from the Editors

By Robert He and Baoyan Liu (Cheryl)

IN THIS ISSUE, WE ARE GLAD TO PROVIDE THREE RELATIVELY LONG ARTICLES SO THE AUTHORS CAN EXPLORE THE TOPICS IN MORE DETAILS. To some extent, the topics are all very important but not have been discussed in previous issues.

As part of our recurring feature, "Insights from Wall Street," we have "Art of Hedging" written by Christopher Metli and Boris Lerner from Morgan Stanley. This great piece of research and analysis is intended to help risk managers and investors to make better risk management and hedging decisions. The original article is very comprehensive and covers many key aspects of hedging. For this August issue, the paired down article introduces a hedging framework that could be used to guide hedging design and discusses in details about the difference of two important hedging instruments—S&P put options and VIX based derivatives. We hope the readers will appreciate many practical insights from this article.

In "Fatness of Tails in Risk Models," David Ingram introduces a metric called "Coefficient of Riskiness" which is derived from the commonly used average and standard deviation. This new metric would complement the Coefficient of Variance measure that is commonly used by modelers to compare volatility of different models.

In "Realizing ERM's Potential: Driving Strategic Execution and Stock Value Growth," Damon Levine encourages risk managers to move away from the defensive angle (downside protection) so often emphasized in ERM to value creation by exploiting risk-intelligent opportunity. This article provides an overview of the Stock Value Approach (SVA) to ERM as a solution to these common challenges.

As usual, we provided a list of recent articles and papers that may be of interest to the members. These pieces can provide further information on a broad range of topics.

We would like to give a special thank you to David Schraub, and Kathryn Baker for helping us pull together this August newsletter.

Enjoy reading and please let us know your thoughts about this newsletter and the articles.

Robert He, FSA, CERA, is VP ALM & Capital Markets at Guggenheim Insurance in Indianapolis, Ind. He can be reached at *robert.he@guggenheiminsurance.com.*

Baoyan Liu (Cheryl) , FSA, MAAA, is senior manager, risk management, at FWD Life Insurance in Hong Kong. She can be reached at *cheryl.by.liu@fwd.com.*

Solvency II Equivalence

On June 5, 2015, the European Commission adopted a first package of third country equivalence decisions under Solvency II. Switzerland was granted full equivalence while Australia, Bermuda, Brazil, Canada, Mexico and the United States received temporary equivalence status (10 years and covers solvency calculation). These decisions now need to pass other formalities and other equivalence decisions are envisaged in the future. Please see *http://europa.eu/rapid/press-release_IP-15-5126_en.htm* for more information.

Fatness of Tails in Risk Models

By David Ingram

ALMOST EVERY BUSINESS DECISION MAKER IS FAMILIAR WITH THE MEANING OF AVERAGE AND STANDARD DEVIATION WHEN APPLIED TO BUSINESS STATISTICS. These commonly used and almost universally understood terms can be used as the basis for a new metric of "fatness of tails." This new metric, called "Coefficient of Riskiness," would complement the Coefficient of Variance measure that is commonly used by modelers to compare volatility of different models. This new metric would similarly allow for comparisons of tails.

David Ingram, FSA, CERA, FRM, PRM, MAAA, is EVP and head of ERM Advisory Services at Willis Re in New York, N.Y. He can be reached at *dave.ingram@willis.com.*

EXTRAPOLATING THE TAILS OF THE RISK MODEL

The statistical approach to building a model of risk involves collecting observations and then using the data along with a general understanding of the underlying phenomena to choose a Probability Distribution Function (PDF). The parameters of that PDF are then chosen to a best fit with both the data and the general expectations about the risk.

This process is often explained in those terms—fitting one of several common PDFs to the data. But an alternate view of the process would be to think of it as an extrapolation. The observed values generally fall near to the mean. Under the Normal PDF, we would expect the observations to fall within one standard deviation of the mean about two thirds of the time. Within two standard deviations almost 98 percent of the time. When modeling annual results, it is fairly unlikely that we will have even one observation to guide the "fit" at the 99 percentile.[1]

So, in most cases, we really are using the shape of the PDF to extrapolate to a 99 percentile or 99.5 percentile value. But our method of describing our models presents that fact in a fairly obtuse fashion. Sometimes model documentation mentions the PDF that we use for this extrapolation. Rarely does the documentation discuss why the PDF was chosen. In the cases where this selection process is discussed, it is almost never mentioned that it is judgment of the modeler that drives the exact selection of the parameters that will determine the extreme values via the extrapolation process.

After the 2001 dotcom stock market crash, many modelers of stock market risk adopted a regime switching model as a technique to create the fat tails that many realized were missing from stock market risk models.[2]

But how fat were the tails in these regime switching models? Would reporting the skew and kurtosis of the resulting model help with understanding of the model? Or is the regime-switching equity risk model now a black box that can only be understood by other modelers?

We use the idea of extrapolation to construct for this new proposed measure of fatness of tails. The central idea is that we will have a three point description of our risk model—mean, standard deviation and Coefficient of Riskiness. With these three terms we can describe the degree to which we can expect a risk to have common fluctuations that will drive variability in expected earnings (mean and standard deviation) as well as an indication of the degree to which this risk might produce extreme losses of the sort that we generally hold capital for.

COEFFICIENT OF RISKINESS

Many remember the words of David Viniar, CFO of Goldman Sacks, who famously observed during the financial crisis that "we are seeing things that were 25 standard deviation moves, several days in a row."[3]

As we will show shortly, for some models, moves of many multiples of standard deviations may be expected. The Coefficient of Riskiness (CoR) is defined to help with discussing this quality of risk models. The CoR is the number of standard deviations that the 99.9 percentile value is from the mean.[4]

$$\text{CoR} = (V_{.999} - \mu)/\sigma$$

The CoR can be quickly and easily calculated for almost all risk models. It can then be used to communicate the

"Many remember the words of David Viniar, CFO of Goldman Sacks, who famously observed during the financial crisis that '*we are seeing things that were 25 standard deviation moves, several days in a row*' "

way that the risk model predicts extreme losses, allowing for actual discussion of extreme loss expectations with non-modelers. We use the mean and standard deviation in defining the CoR, not because they are the mathematically optimal way to measure extreme value tendency, but because they are the two risk modeling terms that are already widely known to business leaders.

Potentially, the CoR could become a part of the process for the initial construction of risk models, taking the position of a Bayesian prior in the common situation where there are no observations of the extreme values. And, if CoR has been established as a common idea with non-modelers, they could have a voice in the process of determining how the model will approach that part of the risk modeling puzzle.

The CoR value will not be a reliable indicator for models where the standard deviation is not reliable. It is instructive to identify the characteristics of such models and the underlying risks that such models seek to capture.

COEFFICIENT OF RISKINESS FOR VARIOUS PROBABILITY DISTRIBUTION FUNCTIONS

The CoR for the Normal PDF is 3.09. This is true for all models that use the Normal PDF, because all values of a Normal PDF are uniquely determined by the mean and standard deviation.

Another commonly used PDF is the Lognormal. The lognormal model has two characteristics that make it popular for risk models—it does not allow negative outcomes and it has a limited positive skew.

As it turns out, the CoR is a function of the Coefficient of Variance for the Lognormal PDF.

Table 2 suggests that very large CoR values are possible for models of risks with standard deviation that are very small compared to the mean (CV close to zero above).

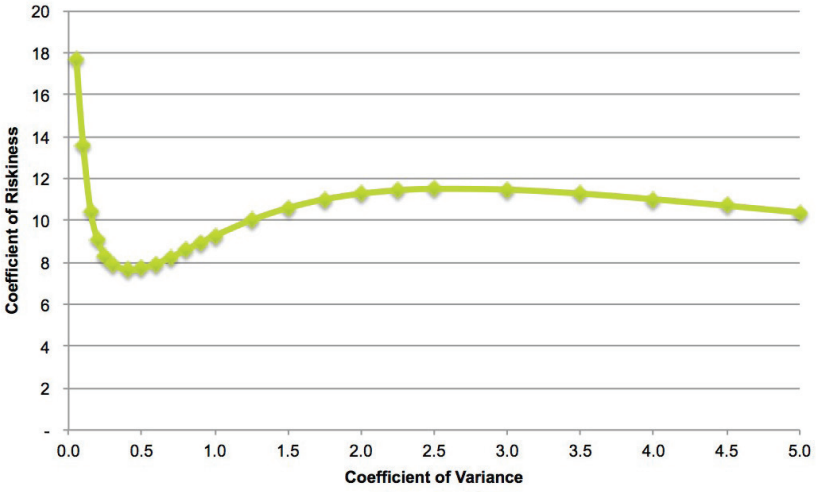
The Poisson PDF is also widely used because of its relationship to the binomial distribution. Since the Poisson PDF is fully determined by a single parameter, the CoR is always approximately 3.5.

Table 1: Lognormal PDF: CoR

Coefficient of Riskiness for Various Means/ Std Dev Combinations

Standard Deviation	Mean				
	100%	80%	40%	20%	10%
7%	17.7	14.9	9.6	7.7	8.2
10%	13.5	11.7	8.3	7.7	9.3
15%	10.5	9.3	7.7	8.4	10.6
20%	9.0	8.3	7.7	9.3	11.3
25%	8.3	7.8	8.0	10.0	11.5
30%	7.9	7.7	8.4	10.6	11.5
40%	7.6	7.7	9.3	11.3	11.0
50%	7.7	8.0	10.0	11.5	10.4
60%	7.9	8.4	10.6	11.5	9.7
70%	8.2	8.8	11.0	11.3	9.1
80%	8.6	9.3	11.3	11.0	8.6
90%	8.9	9.7	11.4	10.7	8.1
100%	9.3	10.0	11.5	10.4	7.6
120%	9.9	10.6	11.5	9.7	6.8

Table 2: Lognormal: CoR vs. CoV



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The Exponential PDF and its close cousin, the Pareto PDF, are used for a variety of types of risks. These risks all have the characteristic that they are usually fairly benign but in rare instances, they produce extremely adverse outcomes. Operational risks are sometimes modeled with an Exponential PDF. Risks from extreme windstorms and earthquakes are also modeled with Exponential PDFs as is pandemic risk.

The Exponential PDF models can produce a wide range of CoR values. Standard deviation, the Normal PDF concept, does not always work well for an Exponential PDF. In theory, the standard deviation (as well as the 99.9 percentile value) can actually be infinite. This may be an insurmountable problem with using the CoR on Exponential PDF risk models.

To solve that problem, some models use truncated exponential models. Truncated exponential models will have finite variance but might still have unstable sample values at the 99.9 percentile and therefore unstable CoR.

The situations where the CoR cannot be reliably applied to an exponential PDF are those that are characterized as "Wild Randomness" and "Extreme Randomness" by Mandelbrot[5] on his seven point scale of varieties of randomness. If you want to use CoR to compare your risk models, you can just mark these models with infinite variance as WR or ER. Hopefully, your WR and ER risks will be a small part of your overall risk profile and there will be a finite variance for the entire company risk model.

Extreme value analysis (EVT) does not, by design, permit a generalized look at a statistic like CoR because it is fundamentally an approach that divorces the tail risk analysis from the data regarding the middle of the distribution that make up the mean and standard

deviation. However, individual risk models that blend a model of expected variation around the mean with a specific model of the extremes based upon the generalized extreme value distribution can produce values that would lead to a CoR calculation and CoR could help to provide a metric for comparing risk models that incorporate EVT with other risk models that do not.

EXAMPLES FROM INSURANCE RISK MODELS

The author has obtained summary information from approximately 3400 models of gross (before reinsurance) property and casualty insurance risks that were performed over the 2009 to 2013 time frame by actuaries at Willis Re.

In addition, we have obtained summary output from stand-alone natural catastrophe model runs for property insurance.

It is interesting to note that none of these models showed a 99.9 percentile result that was 25 standard deviations. But, as you see, the natural catastrophe models did produce CoR values as high as 18.

What you can see from three examples is that CoR does seem to be bounded for these actual models into the range of 3–18 and that existing processes for modeling insurance risks do already produce a range of CoR values.

COMMUNICATING RISKINESS WITH COR

Non-technical managers are usually familiar with the ideas of mean and standard deviation as the defining terms for statistical models. The CoR described here is proposed as a substitute for a discussion of the characteristics and implications of the selection of PDF that in general, is needed but is not taking place.

The CoR, if adopted widely, could come to be used similarly to the Richter scale for earthquakes or the Saffir-Simpson Hurricane Wind Scale. If you were presenting a model of hurricanes or earthquakes and mentioned that you had modeled a 2 as the most severe event, everyone in the room would have a sense of what

Chart 1

3400 Insurance Risk Models[6]

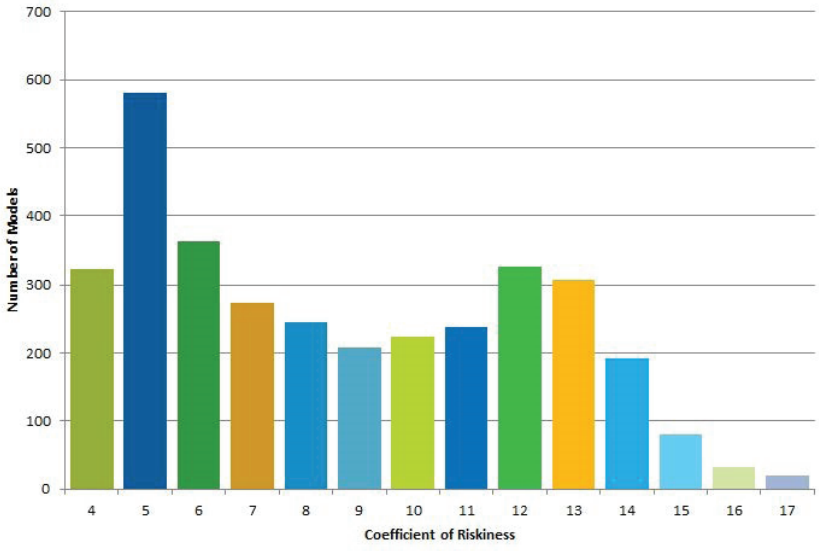
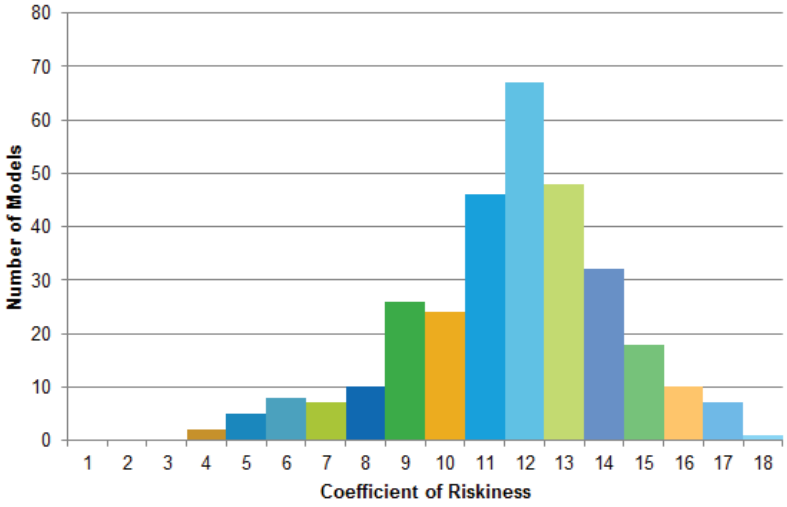


Chart 2

400 Natural Catastrophe Models



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that meant, even if they do not know anything about the details of the modeling approach. They will have an opinion about whether a 2 is the appropriate value for the most severe possible hurricane or earthquake. They can easily participate in a discussion of the assumptions of the model on that basis.

The CoR does not really add any information about the model for PDFs such as the normal, lognormal and Poisson. However, the adequacy of those models to produce appropriate extrapolations of the fat tails actually experienced should by now be highly suspect. But it then does allow for quick comparison of fatness of tails of those models that use a single PDF with those models where different PDFs are used for frequency and severity of risk, for example.

The CoR could become a familiar tool for broad communication of model severity. If you believe that Vineir's comment about 25 standard deviations was actually based upon a measurement (rather than a round number exaggeration to make a point), then you would doubtless reject the validity of the model with a CoR of 3 or 4. If non-technical users of a risk model gained an appreciation of which of the company's risks have CoR of 3 and which were 12's that may be a large leap of understanding of a very important characteristic of the risks.

The hope is that by turning away from the technical, statistical discussion about choice of PDF and parameterization, the discussion can actually tap into the extensive knowledge and experience and gut feel of the non-technical management and board members. Perhaps the CoR can become like the Richter scale of risk models. Few people understand the science or math behind the Richter scale, but everyone in an earthquake zone can experience a shake and come pretty close to nailing the Richter score of that event without any fancy equipment. And they know how to prepare for a 4, a 5 or a 6 quake. The same goes for the Safir-Simpson Hurricane Wind Scale.

CONCLUSION

"If you don't know where you are going, any road will take you there"
– Lewis Carroll

People naturally observe risk in the form of the range of experienced gains and losses. In statistical terms, those observations are represented by standard deviation. Statistical techniques that have long been applied to insurance company risks to develop central estimates are being used to calculate values in the extreme tails of the distribution of gains and losses. These processes are essentially an extrapolation from the "known" risk of volatility near the mean to "unknown" risk of extreme losses.

To date, there is no established language to talk about the nature of that extrapolation. The CoR described here is an attempt to bridge that gap. The CoR can be used to differentiate risk models according the fatness of the tails and could become a standard part of our discussion of risk models. With the use of a metric like the CoR, we believe that the knowledge and experience of non-technical management and board members can be brought into the discussions of risk model parameterization. The end result of such discussions will both ultimately improve the models and increase the degree to which they are actually relied upon for informing important decisions within a risk taking enterprise. ■

This article is a summary of the paper that won the Best Practical Paper awarded by the JRMS at the 2015 ERM Symposium.

ENDNOTES

[1] Some one-year loss calculations are performed by calculating a value for a much shorter period and extending that calculation to the full year by making an heroic assumption about the relationship between that short period and the full year. That substitutes a problem from that time period assumption for the lack of actual data about full year risk. And whether practitioners realize it or not, that process is an extrapolation into the unknown.

[2] Mary R. Hardy, "A Regime-Switching Model of Long-Term Stock Returns." *North American Actuarial Journal* Volume 5, Issue 2 (2001).

[3] *Financial Times*, August 13, 2007.

[4] The 99.9 percentile is chosen to be beyond the values most often used from the model. All of the ideas presented here about CoR would apply with a different chosen reference point.

[5] Benoit B. Mandelbrot, *Fractals and Scaling in Finance*, Springer, 1997.

[6] For this chart and the following, the CoR of 4, for example, indicates a value between 3 and 4.

LIVING to 100

SOCIETY OF ACTUARIES
INTERNATIONAL SYMPOSIUM

Call for Papers—2017 Living to 100 Symposium

The Committee on Living to 100 Research Symposia requests professionals, knowledgeable in the important area of longevity and its consequences, prepare a high quality paper for presentation for the 2017 Living to 100 Symposium. The topics of interest include, but are not limited to:

- theories on how and why we age,
- methodologies for estimating future rates of survival and
- potential benefits and risks associated with the increasing numbers of retirees and potential answers to other difficult issues that arise.

Please submit an abstract or outline of your proposed paper by Sept. 30, 2015. The abstract should include a brief description of the subject of the paper, data sources and methods to be used, key items to be covered, and how your paper will contribute to current knowledge, theory and/or methodology.

A brief curriculum vitae or resume is also required.
Submit the information by email to:

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Email: *jschuh@soa.org*

Learn more about the call for papers, including the complete topic list, by going to Livingto100.soa.org

Questions may be directed to Ronora Stryker, research actuary, at *rstryker@soa.org*.

Realizing ERM's Potential: Driving Strategic Execution and Stock Value Growth

By Damon Levine

THE STOCK VALUE APPROACH

In many companies enterprise risk management (ERM) is regarded primarily as protection against severely adverse events or, worse yet, as a sort of appendage created mostly to satisfy external stakeholders.

To truly influence strategic decision making and embed a risk management mentality in all business lines, risk managers must fundamentally change both their approach and their messaging. We must move away from the defensive angle so often emphasized in ERM and convey that in addition to downside protection we can visibly create value and exploit risk-intelligent opportunity. This article provides an overview of the *Stock Value Approach* (SVA) to ERM as a solution to these common challenges.

Damon Levine, CFA, is vice president, Enterprise Risk Management at Assurant in New York, N.Y. He can be reached at *damon.levine@assurant.com.*

SVA weaves the goal of share price growth into the "DNA" of an ERM framework and enables decision making through a risk-reward lens. We illustrate SVA's application to an insurance company but the approach is well suited for any public company.

DRIVERS OF STOCK PRICE

A very common approach to risk identification is to ask management and various subject matter experts (SMEs) to consider what can harm the company. It is important to realize that this approach necessarily leads to a version of ERM that is focused solely on the downside and will typically not resonate with line management. By asking very different questions we may create a distinct breed of ERM: one which links to strategy and drives growth in stock price.

At a hypothetical insurance company (the Company) the Risk Management department (RM) facilitates a discussion with the Investor Relations department (IR) and addresses the following questions:

1. What are the key drivers for our stock valuation?
2. What specific stock valuation models do our analysts use most frequently?

IR suggests the following are key drivers for sentiment on stock valuation: execution of publically communicated goals (mainly increasing sales in Latin America and achieving the return on equity (ROE) target for the property & casualty (P&C) division as described at Investor Day), strong cash flow, earnings growth, and earnings diversification. They feel that the *dividend discount model* (DDM) and *price to earnings ratio* (P/E) are the most commonly used valuation models by analysts tracking the Company.

RISK IDENTIFICATION AND THE RISK-VALUE MAPPING

SVA views *risk* as uncertainty or volatility around planned or expected business objectives. This interpretation naturally includes upside as well as downside. If upside is systematically excluded from risk models then the modeled probability of missing performance targets will likely be very inflated.

Continuing with our example, RM works with IR, SMEs and management to describe the "ideal future state" in terms of the Company's main goals for the next year. The enterprise goals are shown below with their short hand title in capitals:

I. EARN: Achieve earnings growth of 5 percent versus last year

II. CASH: Achieve an increase of 7 percent in net cash flow versus last year

III. LATAM: Demonstrate a more diversified product portfolio by expanding LATAM sales to at least 5 percent of Company sales

IV. ROE: Meet the return on equity target of 12 percent for the P&C division

V. BEST: Maintain capital levels which target A ratings from AM Best for all legal entities

VI. CAP: Maintain a level of deployable capital at the holding company level which enables a high confidence of continued operations for the next two years (this capital level is determined to be sufficient in 99.5 percent of risk scenarios as quantified in a stochastic enterprise risk model)

Our discussions with IR suggest that the first four goals should positively influence the inputs of the DDM and P/E models used by analysts.

Given the list of key goals, RM works with SMEs to describe the tasks and smaller "sub-goals" which are necessary to achieve them. Those discussions yield crucial information which is largely related to project management and strategic execution.

This is where risk comes in: we identify the potential obstacles to achieving the various goals, sub-goals and tasks as well as challenges or conditions which may affect the quality of our execution or the attainment of our objectives. This includes internal and external risks as both must be identified and, if deemed appropriate, actively managed to help ensure success.

The following list shows each enterprise goal followed by an example of an associated critical to success sub-goal ("CtS") and related threats to attainment of the CtS.

EARN CtS goal: "achieve internal earnings forecast in 3D printer warranty line." At risk due to high rates of malfunctions in some new brands of 3D printers and inefficiencies in claims processing.

CASH CtS goal: "reduce number of ventures with large upfront cash investments and increase sales in fee based products." At risk due to misaligned new business development incentives/compensation and marketing effectiveness.

LATAM CtS goal: "roll out training and IT infrastructure by end of Q1." At risk due to resource/planning challenges in both the Sales and IT departments.

ROE CtS goal: "reduce expenses by 5 percent versus last year." At risk due to IT legacy systems and sub-optimal negotiated rates for print marketing materials.

BEST CtS goal: "forecast accurate statutory financials and link to capital management." At risk due to poor validation of assumptions in the planning process and volatile claims in the earthquake insurance line.

CAP CtS goal: "establish a capital management policy which dynamically links to the risk profile as described in the enterprise risk model." At risk due to uncertainty on new business sales and unknown pricing for catastrophe reinsurance purchases.

Note that if this exercise were performed for an actual company the list would be larger and would have much more detail. In addition, the Company would identify regulatory, legal, and compliance risks.

Observe that each risk affects the outcome of one of the enterprise goals and each of these goals ties to a specific driver of the Company's stock valuation. This may be described as a "mapping" of each risk to a stock value driver. For example, it has been seen that IT legacy systems may affect the CtS goal of reducing expenses by 5 percent versus last year and therefore affects the ROE goal. The achieved ROE is known to inform the analyst models and therefore drive the Company's stock valuation.

The Exhibit 1, on page 14, illustrates such a mapping for the EARN goal.

By focusing on drivers of stock price we identify many strategic, operational, and insurance risks. This inclusion of many "internal" factors in the Company's sphere of influence is a very important benefit. In many ERM programs, risk identification places far too much emphasis on "external" or *force majeure* risks that the company cannot affect. This makes ERM a largely irrelevant exercise: too much focus is placed on risks that cannot realistically be managed. SVA's emphasis on stock value drivers leads to inclusion of many sources of performance variability that the company

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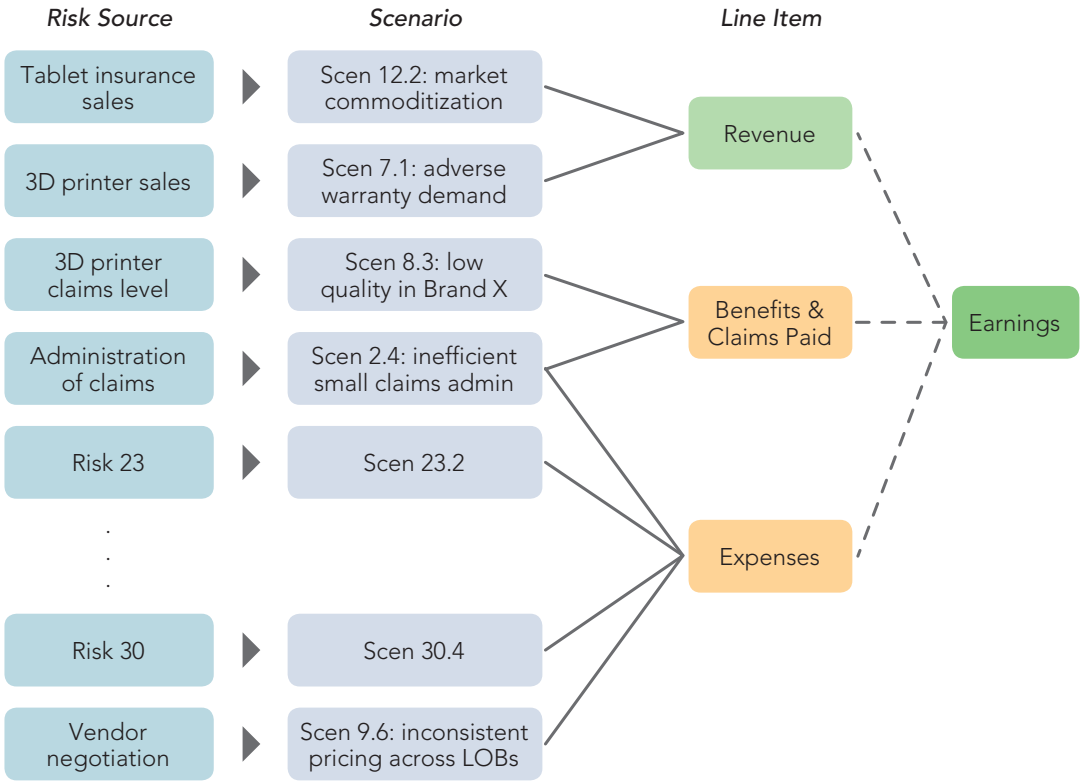
Exhibit 1 A Risk-Value Mapping for Earnings



may influence, through risk mitigation and/or strategic decisions, with obvious rewards.

SELECTION OF RISK METRICS AND QUANTIFICATION

At this point we move from discussion of SVA's approach to risk identification to some of the other elements of any ERM framework, namely risk metrics and risk quantification. It will be the *right* choice of risk metrics and the quantification approach that will allow for clear links across risk management, strategy, and stock value growth. Risk metrics which are appropriate for one company may not be so for another. Appropriate selection will depend on enterprise goals, company culture, risk appetite, and management style.

For the sake of brevity we will not discuss the risk quantification model (RQM) details but it will be assumed that for each risk source we are able to quantify the impact to several years of income statements and balance sheets. Additionally, the model should capture a continuous range of impact results rather than only capturing a few specific dollar outcomes.

RM facilitates discussions with management, the Board, IR, and Strategy groups to determine appropriate metrics to track progress and risk relating to the stated enterprise goals and the Company decides on risk-based forecasts of the following metrics to assess the risks to achieving the six goals:

I. earnings growth

II. net cash flow growth

III. LATAM sales

IV. ROE for P&C division

V. shortfall versus A-rated target capital levels

VI. shortfall versus targeted level of holding company deployable capital

The shortfalls in V and VI are defined as min (0, modeled value - target value) so shortfalls are negative values and a zero corresponds to a target being met or exceeded. This ensures that for all metrics above, a larger numerical value is a better result. These metrics are denoted m1, m2, …, m6.

RISK-INTELLIGENT DECISION MAKING

We now introduce a single metric defined as a function of the above six metrics. This will enable analysis that takes into account all of the most important risk-reward metrics in a single quantity. Additionally, it will reflect the relative importance of its components as perceived by the Company.

Rather than using the metrics m1, m2, …, m6 directly in a weighted average, we will use scaled metrics (e.g., each is restated on a 1-10 scale defined by management) to form a weighted average metric, M. This scaling is important because some of the metrics are percents and others are dollar amounts and care should be taken to ensure that the relative size differences do not unintentionally inflate the importance of some metrics versus others in a weighted average metric.

Based on the perceived levels of importance of each metric, the Company reaches consensus on priority weightings to define a single metric M as a weighted average of the above six scaled quantities.

A carefully designed RQM captures each of the component metrics of the weighted average metric M. The RQM may be run stochastically to produce many simulations of risk manifestation and the resulting values for M and its component metrics.

As a result, for the risk sources captured in the model we can prioritize or rank them based on a myriad of metrics including the value or deviation from the financial plan of:

- Earnings
- Free cash flows
- ROE
- any specific mk
- M

Clearly, M contains significant information linking the Company's risk-reward profile to key drivers of stock value. When considering risk response one may analyze the various options by estimating the effect on M. It is possible that mitigation for certain risk scenarios shown in the rankings mentioned above can be addressed in a much more economical way than for others.

Simulation of the *distribution* for M is a straightforward result of running the RQM and enables determination of the percentiles of results for M, the average or expected value of M, as well as volatility measures such as standard deviation of M. Given several strategic choices or risk mitigation alternatives we may run the model assuming each particular option in turn. We may then develop an efficient frontier for these options with, for example, risk captured by standard deviation of M and reward defined as the average value for M.

Additional detail on SVA and its applications, including risk-based compensation and forecasting, can be found in the original research paper "Growth in Stock Price as the ERM Linchpin" at: *http://www.ermsymposium.org/2014/pdf/erm-2014-paper-levine.pdf.*

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The Art of Hedging

By Boris Lerner and Christopher Metli

INVESTOR HEDGING BEHAVIOR HAS EVOLVED OVER THE LAST FIVE YEARS, FROM AN INTENSE FOCUS ON BUYING TAIL RISK PROTECTION AT ANY PRICE TO A MORE NIMBLE APPROACH IN RECENT YEARS. But in one form or another, hedges continue to be bought as institutional investors remain hesitant about the sustainability of the bull market. While VIX is at the low end of its historical range (although certainly not the lowest on record), that does not necessarily mean hedges are cheap. Implied volatility continues to trade above realized volatility, and downside options are more expensive than ATM volatility would suggest.

For many investors, systematically buying puts month after month is not a viable strategy. This has been particularly true over the last several years, when market pullbacks have been shallow and short, and payouts on hedges have been compressed. But despite the challenges, hedging and risk management remains critical to an efficient portfolio design.

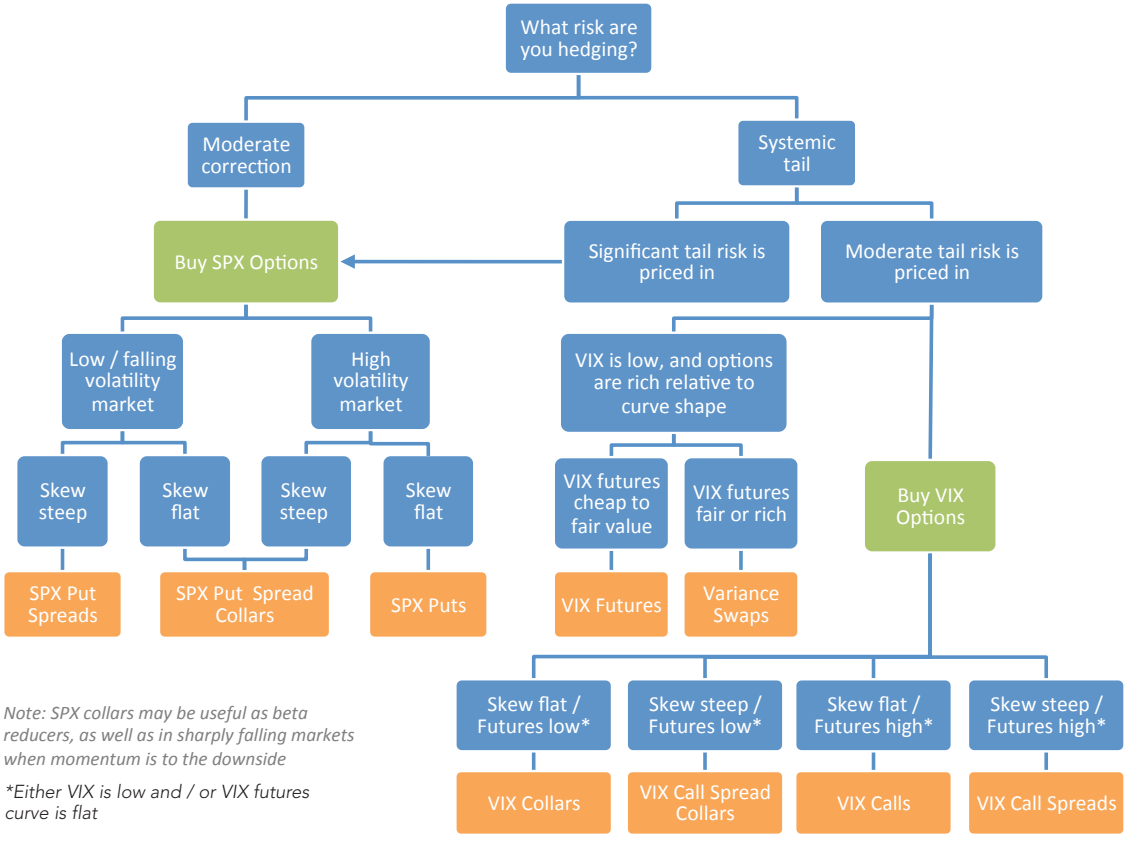
Institutional investors seeking to hedge have no shortage of choices, and need the right framework to manage the different risks in portfolios as they arise. After studying the performance of over 100 different strategies using S&P 500 options, variance swaps, VIX futures, and VIX options during the last 15 years, we think institutional investors should consider a hedging framework such as Exhibit 1 that takes into account:

1. The ***type of risk being hedged*** (systemic large tail versus a fundamental moderate correction).

2. ***Fundamental views*** of the balance of risks and likely scenarios in the market,

3. Current ***market pricing of protection***.

Exhibit 1: A Framework for Hedging



Note: SPX collars may be useful as beta reducers, as well as in sharply falling markets when momentum is to the downside

**Either VIX is low and / or VIX futures curve is flat*

Source: Morgan Stanley Quantitative and Derivative Strategies

While much of the time spent designing a hedging program ends up being spent on selecting the right option expiry, strike, etc., perhaps the most important decision is a more basic one—what risk are you trying to hedge? ***We find that if your view is for a large and systemic selloff—greater than what is priced by the market—then a volatility-based hedge can potentially make more sense. For smaller and more-fundamentally driven selloffs, directional hedges via equity options may be the more appropriate choice.***

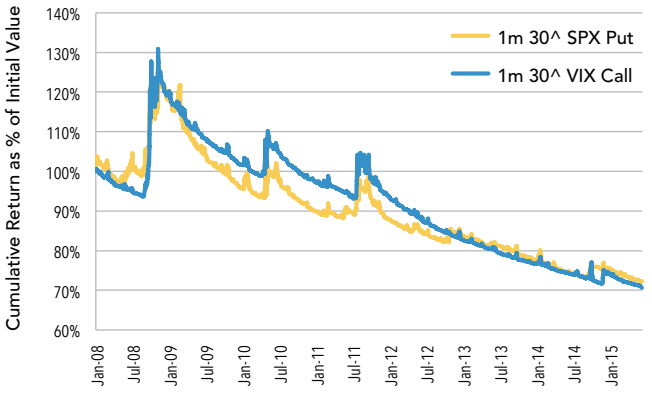
The simple backtest of 1-month 30-delta SPX puts and 30-delta VIX calls in Exhibit 2 highlights the differences between the two strategies (this is scaled using a 1 point change in volatility: 1 percent SPX return assumption). Performance is broadly similar, but ***VIX calls have a larger—and faster—payoff in tail events*** such as the 2008 Credit Crisis, 2010 Flash Crash and 2011 US downgrade, while SPX puts outperformed in more recent moderate corrections. This is the key behavior of a volatility based hedge—volatility rises disproportionately more with larger moves down in the S&P 500 than it does for small selloffs.

However, this convexity is not free—it is priced into VIX options. In normal markets, ***VIX call options expire in-the-money less often than S&P 500 options***—see Exhibit 3. VIX calls also do not capture some of the more moderate drawdowns as well as S&P 500 hedges—if an event is not one that precipitates forced liquidation and a rush to buy more hedges, volatility hedges will typically underperform equity options. But the profit on VIX calls when they are in-the-money is typically higher than it is for SPX puts (i.e., VIX can double or triple, while the SPX cannot fall by more than 100 percent).

Exhibit 4 shows the rolling average returns of VIX calls and S&P 500 puts, as well as which trade was the most effective hedge for the S&P 500 in a given month (hedge effectiveness = zero cost SPX ATM put less the P/L of the hedge, with a lower number meaning a better hedge)[1]. ***In calm markets the costs tend to be similar between the two instruments***—2012 happened to favor SPX puts,

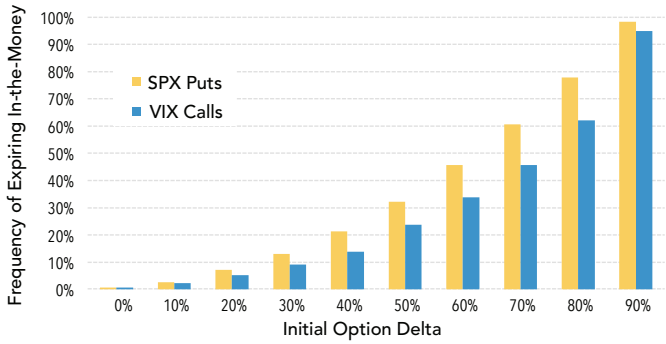
CONTINUED ON PAGE 18

Exhibit 2: VIX Calls versus SPX Puts, Beta-Neutral (1% Vega)



Note: 1% vega based on a 1 point move in VIX for every 1% change in SPX.
Source: Morgan Stanley Quantitative and Derivative Strategies

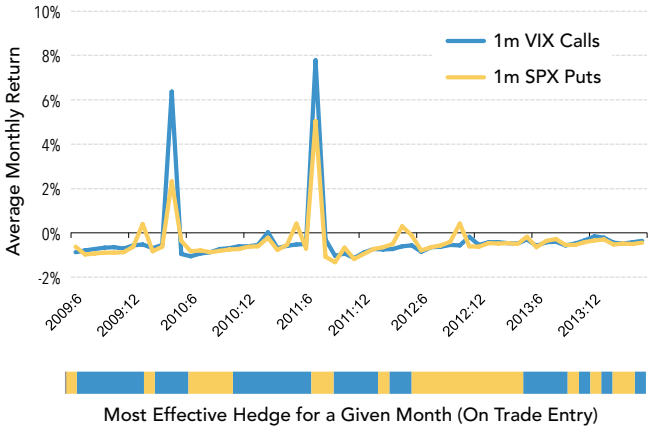
Exhibit 3: VIX Calls Expire ITM Less Often than SPX Puts



Frequency of options with 10-60 days left to expiry expiring in-the-money since June 2009

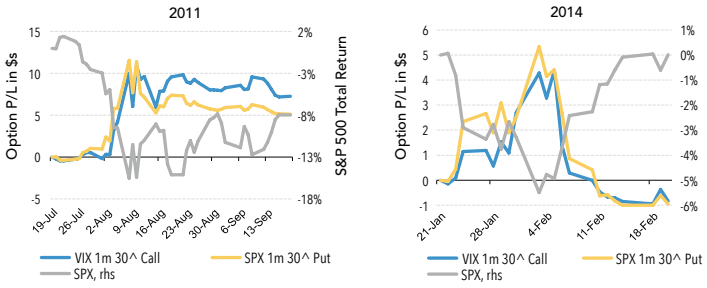
Source: Morgan Stanley Quantitative and Derivative Strategies

Exhibit 4: VIX Call versus SPX Put Hedge Effectiveness



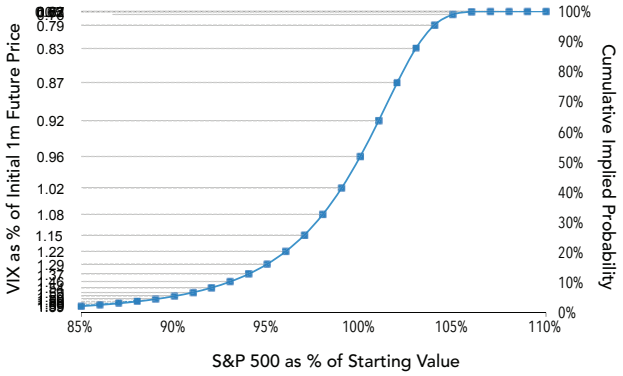
Source: Morgan Stanley Quantitative and Derivative Strategies

Exhibit 5: Selloff Performance ($1 Premium Spent on Each Option)



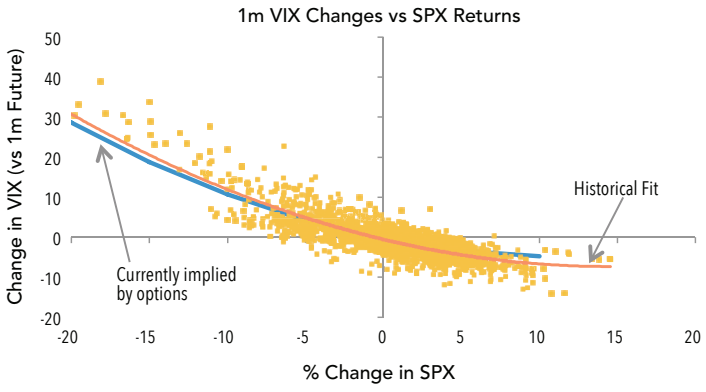
Source: Morgan Stanley Quantitative and Derivative Strategies, Bloomberg

Exhibit 6: Aligning the Distributions



Source: Morgan Stanley Quantitative and Derivative Strategies, Bloomberg

Exhibit 7: Market Pricing of Tail Convexity



Source: Morgan Stanley Quantitative and Derivative Strategies, Bloomberg

late 2013 VIX calls, but in general the trades are similar. But in selloffs they can diverge—***VIX calls outperformed in 2011 and 2010, while the modest declines in 2012 favored SPX puts***.

The case studies in Exhibit 5 show in greater detail how large tail and moderate tails could unfold; the first is August 2011, the second is the early 2014 EM-led selloff. In 2011 the VIX calls outperformed as fear persisted in the marketplace. In the early 2014 selloff, however, S&P 500 puts where the better performer—although as markets rallied back both hedges ended up performing similarly.

Key to any effective trading strategy, however, is not just knowing the right product—it is knowing what the market is pricing in. One approach for determining this is to ask the question "What are the options markets saying VIX could do if the SPX sells off?" To tease that information out of market pricing, we use the fact that VIX and SPX typically move very closely together, and make a simplified assumption that changes in the S&P 500 map perfectly to VIX (i.e., ignore the chance that VIX may move in a different direction than the S&P 500). We then take the option implied distribution of future SPX returns and line it up versus the option implied distribution of VIX returns (Exhibit 6).

For example today the market prices that the S&P 500 in one month will be below 95 percent of the current price with a 15 percent probability, while also pricing that the VIX will be more than 129 percent of today's futures level with a 15 percent probability[2]. Taken together, we can say the market estimates VIX will move 29 percent—roughly 4 points—for a 5 percent decline in the SPX.

Applying these matches across the full spectrum of possible returns in the S&P 500, we obtain a market-implied VIX versus SPX relationship (the blue line in Exhibit 7), and compare this to what occurred historically (the red best-fit line). This gets at the key consideration when looking at relative value of VIX versus SPX options: ***how much does the market expect VIX to rise if the S&P 500 falls***?

Options markets currently imply that VIX futures should rise ~11 points if the S&P 500 is down 10 percent over a month, slightly cheap versus the historical average.

We can evaluate the performance of hedges under these VIX vs SPX scenarios—both implied and historical—and compare to fundamental views to determine the best hedge. Exhibit 8 shows the payouts as a percent of S&P 500 notional for a 1-month 30-delta SPX put and a premium-equivalent amount of 1-month 30-delta VIX calls (roughly 0.2x contracts). ***If the future unfolds as priced by the market today, VIX options are a better hedge for anything greater than a 8 percent decline in the S&P 500 over a month. If the future repeats the historical average, VIX calls would be more efficient if the market drops by more than 6 percent over the next month***.

The above scenario focuses on hedges held for a month or longer. But an increased focus on risk management following the financial crisis has driven many institutional players, both on the sell side and buy side, to have to protect against overnight or rapid intraday gaps lower—a la 1987 or the Flash Crash. To compare SPX puts to VIX calls in these scenarios we use a combined implied / historical approach—factoring in that in a selloff volatility will roll along the existing skew, and then estimating how the implied volatility surface could shift based on historical relationships (Exhibit 9).

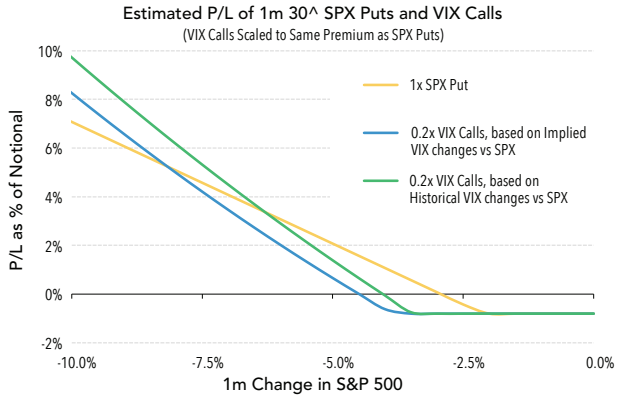
In addition to estimating how the underliers change, we also estimate how implied vol for both instruments might evolve as the market falls, based on historical changes in fixed strike implied volatility relative to S&P 500 returns / VIX futures changes. Compared to SPX, VIX vol-of-vol is much less reactive to changes in the underlying price. In addition, VIX skew tends to flatten (calls get cheaper) as VIX rises. This occurs because VIX is mean reverting, and implied vol and skew reflect this dynamic.

Applying all of these (admittedly rough) estimations produces the scenario analysis in Exhibit 10, demonstrating that for big moves down in the S&P 500, the

CONTINUED ON PAGE 20

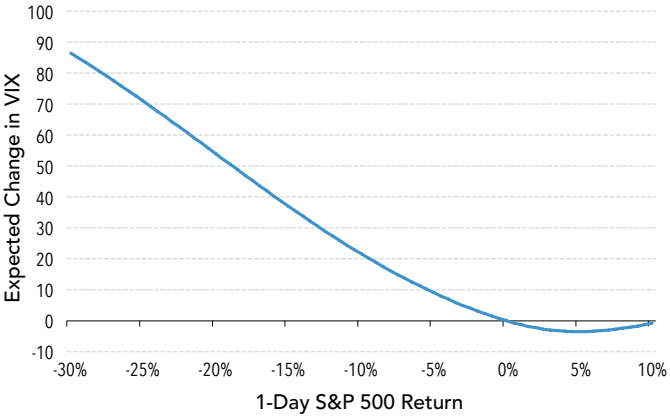
Boris Lerner is an executive director and a head of the Americas Quantitative and Derivative Strategies team at Morgan Stanley in New York, N.Y. He can be reached at *boris.lerner@morganstanley.com.*

Exhibit 8: VIX 1m Calls Priced to Outperform at -7 to -8% on the SPX



Source: Morgan Stanley Quantitative and Derivative Strategies, Bloomberg

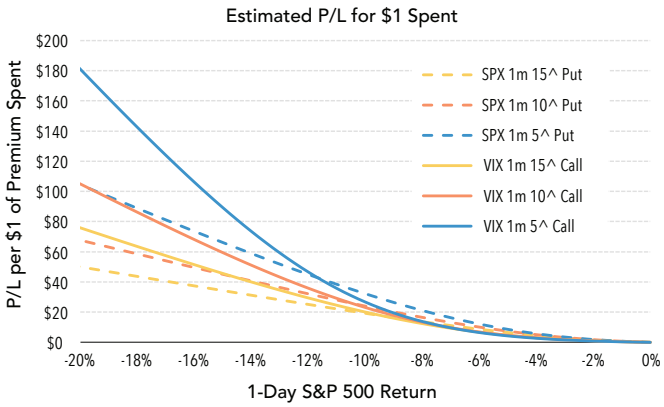
Exhibit 9: Estimated VIX Change for 1-Day SPX Gap



Source: Morgan Stanley Quantitative and Derivative Strategies

Christopher Metli, CFA, is an executive director and a senior derivative strategist at Morgan Stanley in Boston, Mass. He can be reached at *Christopher.metli@morganstanley.com.*

Exhibit 10: VIX Screens Better for Large Gap Risks on Current Pricing



Source: Morgan Stanley Quantitative and Derivative Strategies, Bloomberg

Exhibit 11: Current Premium Spent to Hedge $1,000,000: Cheapest for a Given Decline Highlighted

1-Day Return	SPX 1m 15^ Put	SPX 1m 10^ Put	SPX 1m 5^ Put	VIX 1m 15^ Call	VIX 1m 10^ Call	VIX 1m 5^ Call
-5%	154,986	140,741	125,650	216,567	219,119	239,615
-10%	52,068	44,080	35,688	50,047	43,478	37,584
-15%	29,136	23,735	18,137	21,954	16,851	11,217
-20%	19,964	15,927	11,782	13,196	9,538	5,529
-25%	15,134	11,925	8,652	9,352	6,570	3,581
-30%	12,170	9,513	6,816	7,336	5,077	2,685

Source: Morgan Stanley Quantitative and Derivative Strategies, Bloomberg

convexity of VIX instruments yields the greatest P/L. This assumes $1 of premium is spent on each option.

Given a steep VIX call skew, and the fact that most of the convexity in VIX comes from convexity in the underlying, not convexity in vol-of-vol ***for small declines in S&P 500 it is generally cheaper to hedge using OTM SPX puts. For one day gaps down larger than -10 percent, low delta VIX calls would be a more efficient hedge.***

The table in Exhibit 11 shows the estimated premium that would need to be spent to generate a $1 million profit in given gap risk scenarios. Within each of the VIX and SPX, moving further OTM is always more efficient for these types of moves, and strike selection should only be limited by liquidity.

Investors need to consider the types of risks they are trying to hedge as well as market pricing. When relatively moderate, fundamentally driven corrections are the concern, option based hedges are often the best choice to protect against portfolio drawdowns. But when large systemic tail events are the focus—and market expectations of future volatility are not onerous—volatility based hedges can offer more efficient protection. ■

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ENDNOTES

[1] All 1m term, average of 20, 30, and 40-deltas, scaled to 20-delta on open, scaled so the notional of the VIX calls is 1 percent of the SPX (i.e., one percent vega, consistent with a 1 VIX point move: 1 percent move in SPX)

[2] Option implied probabilities and related charts in Exhibits 6 and 7 are based on SPX and VIX option prices from June 26, 2015.

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